

Aerial Fig. - 8 Fibre Cable Placing

APPLICATION NOTE

ISSUED

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ABSTRACT

Figure 8 Cables are Self -Supporting cable designed for aerial installation. The cable design provides easy and economical one -step installation and stable performance over a wide temperature range and is compatible with any telecommunication grade optical fibre. The strength member is designed to withstand the tensile forces of the installation and may be metallic or non-metallic. The design configurations of this cable consists of central tube or stranded loose tube.

KEYWORDS

Messenger Wire, Figure 8 Cable

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1. Introduction

STL Figure-8 self-supporting optical Fibre cable greatly simplifies the task of placing Fibre optic cable on an aerial plant. It incorporates both a steel messenger and the core of a standard optical Fibre cable into a single jacket of "Figure-8" cross-section. The combination of strand and optical Fibre into a single cable allows speedy one-step installation and results in a more durable aerial plant.

Aerial optical cables are suspended in the air from poles and/or support structures. Most often aerial cables are supported between poles by being lashed to a wire rope messenger strand with a small gauge wire. The strand is tensioned to satisfactorily withstand the weight of the cable for the span length it will be used on plus any climatic loading such as ice, snow, and wind. The objective is to keep the cable and Fibre in as low a state of stress and strain as possible while maintaining sag limitations in the aerial cable that is safe and within limits prescribed.

Figure-eight cables carry their own messenger and do not require a separate messenger strand for support. They get their name from their shape. The messenger is in the top portion of the figure-eight cross-section which has an extruded over jacket. The cable is supported from the messenger strand portion of the cable with a thin plastic web. As with lashed cable, the messenger strand component must be properly tensioned to resist the expected loading.



Figure 1- STL Single-Jacket Loose Tube Figure-Eight Optical Cable for Aerial Applications

The most common OSP uses of the aerial cable family are shown in **Table 1**.

Underground Plant	Urban	New Suburban	Old Suburban	Campuses Rural
Lashed Messenger Strand	•			
Figure-Eight	•	•		

= Used often in this application

= Can be used in the application under certain circumstances

Table 1- Applications for Figure-Eight and Lashed Optical Aerial Plant

2. General

This procedure provides general guidance for the installation of self-supporting cable. The figure-eight aerial cable placing methods described in this document are intended as guidelines. All national, state, local, corporate regulations and industry recommendations normally take precedence over the procedures contained herein. It is impossible to cover all the conditions that might arise during a placing operation. Individual company practices for placing optical cable should supersede any conflicting instructions in this document whenever they do not exceed the cable's optical and mechanical performance specifications. In addition, instructions provided by associated OSP hardware manufacturers should be followed.

The methods used to place figure-eight optical aerial cables are similar to those used to place figure-eight copper cables. Optical cable is a high capacity transport medium that is sensitive to excessive tensile force, tight bends, and crushing forces, therefore, some care must be taken during the installation procedure to respect its limitations.

Optical cables are ordered in lengths as calculated by an OSP (Outside Plant) Engineer to match the service route they will occupy. Their lengths are determined by measuring the distance between the splice points along the pole line plus adding the excess length at both ends of the cable to reach the two splice locations, make the splices, and the required slack storage length for maintenance. Extra length should be included in the ordered length to cover errors made during the splicing operation. If the excess splice length is not known, the splicing foreman should be consulted. Never cut an optical cable without first consulting the OSP Engineer responsible for the job.

3.0 Precautions

3.1 Cable Handling

All optical cables are sensitive to damage during shipping, handling, and installation. Some of the important parameters that need special attention during cable installation are:

- Cable bending radius: Optical Fibre cables are designed with a minimum bending radius and maximum tensile strength. The cable should never be bent below its minimum bending radius. Doing so can result in bending losses and/or breaks in the cable's Fibres. Generally the minimum bending radius of a Fibre cable under load is 20 × D, where D is the diameter of cable; the minimum bending radius of a Fibre cable under no load is 15 × D.
- Cable Placing Tension: Optical Fibre cables are designed with a maximum tensile strength. The cable should never be loaded beyond its maximum tensile strength. Exceeding the cable's placing tension provided by STL in the Cable Data Sheet/Specification, can alter cable and Fibre performance and shorten its service lifetime.

3.2 Cable Handling

LEDs and lasers emit beams that are invisible to the human eye that can seriously damage the eye. Viewing these beams directly may

Never look directly into a Fibre end that has a laser or LED coupled to it.
Never look directly into a Fibre end using any magnifying lense.

3.3 Material Safety

Fibre optic splicing and termination processes often use various chemical cleaners. The safety instructions developed for these substances should be followed. If there is confusion in the usage of these products, consult the product's Material Safety Data Sheet (MSDS).

3.4 Safety During Installation

- Before entering any manhole, test its atmosphere with an approved test kit for flammable, explosive, and poisonous gases.
- Avoid usage of any device that produces a spark or flame in or near a manhole.
- Follow the existing rules for the use of warning signs, barricades, manhole guards, and cones.
- **A** Ensure that all tools and equipment are in proper working order.
- A Be careful when working near electrical wires.
- Bond all metallic materials in the transmission pathway together. Ground the bonded metallic components to a proper earth ground following normal bonding and grounding procedures.

3.5 Personal Protective Equipment

Placing optical cable requires the use of sophisticated operations and equipment. STL recommends using a placing crew that is familiar with the procedures and equipment being used. Approved personal safety equipment, such as hard hats, safety shoes, safety glasses, reflective traffic vests, and gloves shall be used for all outside plant construction activities.

3.6 Traffic Safety

All applicable federal, state, and local departments of transportation and traffic regulations and codes shall be met including the use of safety equipment such as reflective safety vests, warning signs, barricades, and lighting if work is being performed during non-daylight hours.

3.7 Placing Equipment

High pressures are used to drive hydraulic motors as well as air lines. Failure of a high pressure hose or connection is potentially dangerous to those working around it. The placing crew needs to be familiar with all equipment and operating procedures as well relevant safety issues.

3.8 Cable Protection and Reel Handling

- During reel handling care must be taken to prevent collision with other reels, dropping, or damage to the reel or cable.
- Reels should not be rolled a long distance. When rolled they should be rolled in the direction indicated by the arrow on the flange.
- Reels should never be stored on their side.
- Cable reels should be covered with the factory applied UV/thermal wrap until just prior to installation.

4 Preparation for Cable Placing

4.1 Pre-Construction Survey

One of the most important steps in the engineering and placement of optical cable is the pre-construction site survey. During this survey the placing supervisor and/or OSP engineer will perform the site visit to observe any unusual situations that require special attention. The proposed placing route will be evaluated for its ability to support the planned placing procedure.

Refer to STL Application Note Aerial Fibre Cable Placing Methods, Section 5.1 and 5.2 for a summary of issues to accomplish during the pre-construction survey and the pre-construction Fibre measurements. The cables and all reels need to be inspected for damage as they are received. As a precaution and to avoid costly extra cable removal operations, all Fibres should be measured on the reel using an OTDR.

Measurements on single-mode Fibre cables should be made at 1550 nm and 1310 nm. If discrepancies are found with respect to the factory "as shipped" test results on the cabled Fibre, contact STL Technical Support.

5. Unique Messenger Strand of Figure-Eight Cable

The aerial messenger strand portion of the figure-eight cable is designed to support the mechanical and environmental stresses that it and its cable partner will experience. Its strength to weight ratio allows it to support the composite strand/cable between poles (or support structures) without having its Fibres over stressed or from experiencing excessive sag. To achieve this, the messenger strand's installation tension must be adjusted sufficiently to offset the effects of span length, temperature, mechanical loading, wind, and ice. As a result, the Fibre in the cable it supports is capable of remaining nearly stress and strain free, even when it is exposed to full design loads.



Figure 2- Catenary Cable Deflection Sag Drawing of Figure-Eight Aerial Cable

The initial strand tension required depends on its size, the temperature at which the strand is tensioned, and on the average span length. There is a definite tension for each strand size - average span length at each temperature combination. Span mechanics calculations can be assisted using the United States Department of Agriculture, Rural Utilities Service (RUS), Bulletin 1753F-152, Section 5, **Specifications and Drawings for Construction of Aerial Plant, RUS Form 515c.** The initial tension and sag data for the installation of 6M, 10M, and 16M EHS Galvanized Steel messenger strands at various installation temperatures and average span lengths are given in Tables 1, 2, and 3 of RUS, Bulletin 1751F-635.

If STL Technologies is provided with a description of the aerial application's geography, the cable weight and strand size, the NEC Loading District, temperature at installation, and span length it can provide the necessary strand tensioning and sag information for the installation to use.

The aerial span from the last pole outside a building to a building is the only span which may have lower tension than the remainder of the aerial cable route. Installation technicians need to pay close attention in this span to ensure that the cable's minimum bend radius of is not exceeded.

6. Tools and Materials

Aerial cable placement of figure-eight cable is characterized by placing cables onto rollers (cable blocks) supported by poles or support structures. The messenger portion of the cable is then properly tensioned to provide sufficient supporting strength to keep the strain level in the cable portion of the cable Fibres low while experiencing maximum climatic storm loadings while maintaining minimum sag requirements for the figure-eight cable structure.

Table 1 and **Table 2** provide a pictorial summary of the typical equipment and hardware used in placing aerial optical cables.

Aerial Plant Placing Hardware



Aerial Plant Placing Hardware



Safety Devices



Examples of the special placing equipment and hardware that are used to place Fibre cable are shown in **Table 3.**

Table 3- Typical Placing Equipment Used to Place Optical Figure-Eight Aerial Cables

Figure Eight Optical Cable Placing Equipment

Pulling winches



Curved Suspension Clamp



Reel Truck



Heavy Duty Fibre Block GMP



Cable Placing Truck (Canada)

6.1 Sheaves, Quadrant Block, and Manhole Frame

The cable manufacturer's recommended minimum bend diameter shall be maintained. If no minimum bend diameter is recommended, use the minimum diameter recommended below.

Cable under no load, Minimum bend radius ≥15 × Cable Diameter Cable under load, Minimum bend radius ≥20 × Cable Diameter

6.2 Winches

Most standard size optical cables have a maximum cable placing force of 600 pounds or greater. Because some optical cables have higher load ratings and some lower, consult the cable specification provided by STL to determine the maximum placing load for each cable. Optical cable winches tend to be smaller than the line truck bed winches used for copper cables. Capstan winches are popular. Some of these winches are stand alone, using portable power packs (electric or hydraulic) and some are truck or trailer mounted using the hydraulic power take-off from the support truck. Fibre winches should all have a cable tension monitoring systems to ensure that the maximum cable tension is not violated. Slip clutches are often used to limit cable tension for side take-off winches on line trucks.

Route planning and cable selection are technical considerations that are engineering and construction force responsibilities. The objective is to choose a method that imposes the least physical stress on the cable while providing a safe, cost effective solution to the placing problem.

7. Cable Installation of Figure-Eight Self-Supporting Cable

The cable placing operations described in this section does not use a messenger stand as part of its installation hardware. Figure-eight cables carry their own messenger and get their name from their shape. The messenger is in the upper portion of the cable. It has an extruded over jacket of polyethylene. The cable is supported from the messenger portion of the cable with a thin plastic web which is attached to a cable portion of the figure-eight cross-section shown in Figure 4. As with lashed cables, the messenger portion must be properly tensioned to resist the expected loading while keeping Fibres safe and the cable within acceptable sag limits.





Figure-eight cables are supported directly by their support structures (poles) and the tension in the catenary strand they have as part of their design. The tension in this strand must be adjusted to compensate for the weight of the cable, ice, snow, wind, and temperature effects. Cables need to be clamped in place at their dead-end starting point and raised to the next support structure. Their component internal strand needs to be properly tensioned to the appropriate tension to resist the loading it will experience during service. Installation proceeds from span to span positioning the cable on the next support, then tensioning the cable for the loading and span length once the next dead-end point has been reached.

7.1 Figure-Eight Cable

7.1 .1 Separating Figure-Eight Cable Components

The messenger portion of the figure-eight cable must be separated from the cable portion at all dead-end points and all splice closures to properly terminate it in the closure. The two portions of the figure-eight cable can be separated at the web using a web splitting tool (GMP® model # 82730 Web Splitter, or equivalent) or a splicer's knife and then pulling both portions apart.



Figure 5- GMP Model #82730 Web Splitter

The tool is used by positioning its blade over the web at the point to be split. Squeeze the handles of the tool to have its blade penetrate the cable web. Pull the tool along the web causing it to separate the messenger and cable portions of the figure-eight cable. Up to 150 m of cable can be separated with this type of tool.

7.1.2 Separating Figure-Eight Cable Components

Dead-end poles are the anchor points for the tensioned messenger portion of the figure-eight cable at the start and end points of each cable placing operation. They are also used at supports in which the intersecting cables are greater than 30°. The messenger portion of the cable is fixed to dead-end poles with dead-end fittings that maintain the tensile loading of the span. The following paragraphs describe two basic types of dead-end fittings: wrapped strand grips and strand vises.

7.1.2.1 Separating Figure-Eight Cable Components

Dead end grips transfer the strand tension from the messenger strand to the support structure (pole). A typical wrapped dead end grip consists of spirally formed high strength steel wires which are wrapped around the bare messenger strand portion of the figure-eight cable.



- Conner

Figure 6- Wrapped Strand Grip Dead Ends and Wrapped Dead-End Strand Grip (right)

The portion of the wires between the two legs forms an eye when the grip is installed on the messenger. This type of a grip can be used to terminate a figure-eight messenger strand component at a dead end onto a guy hook. The strand grip manufacturer's instructions should be followed when it is used on the figureeight cable.

1. Determine where on the cable strand the wrapped strand grip will be mounted and mark that location on the strand portion of the cable.

- If you are installing the dead-end at the end of a cable span or providing slack for a future splice point (prior to the beginning of cable installation) allow for the appropriate slack cable length requirements for the splice.
- If the dead-end is being installed on a tensioned cable at its installation level, ensure that the span is properly tensioned. Support the figure-eight cable extending beyond the dead end location to prevent damage from bending and or tension once the messenger is cut.

2. Separate the two figure-eight cable components with a web splitter or splicer's knife, starting about 11 inches (27.5 cm) ahead of where the messenger will enter the strand grip. The component separation length may vary with different strand grips. The actual length can best be determined by holding the strand grip you are using alongside the cable.

3. Determine the strip length required to fit both the messenger component of the cable into the strand grip and provide sufficient length for a bonding/grounding clamp to be clamped on the exposed end(s) of the strand. At least 3 inches (7.5 cm) of stripped messenger should extend out of the strand grip toward the pole. Finally, cut the messenger strand to length with a pair of bolt cutters.



4. Remove the jacket from the messenger component of the figure-eight cable by running a splicer's knife along the strand. Peel the jacket away from the strand. Perform this step with care to avoid personal injury and to avoid any damage to the anti-corrosive zinc coating of the strand.

5. Assemble the strand grip on the stripped portion of strand according to its manufacturer's instructions.

6. Use a weather proofing tape around the strand at the point where the jacket is stripped off of the messenger to seal the jacket from water entry.

7. Use weather resistant cable ties or straps to re-connect the separated stand component and cable component at the pole support hardware and to keep the separation from propagating along the cable.

NOTE: Wrapped strand grips should not be reused.

7.1 .3 Strandvise

Another type of dead end grip is a strandvise. The strandvise grips the messenger by using a compression sleeve cartridge that is installed on the messenger component of the figure-eight cable. The sleeve cartridge slips into a yoke and bail to produce a dead end fitting which can be hung on guy hooks bolted to a pole.



Figure 8- Aerial Strandvise Dead End

The strandvise type dead end has a spring-type compression sleeve to grip the bare messenger strand.

NOTE: The cartridge sleeve can be removed from the yoke and bale. The cartridge shall not be reused although it is possible to reuse the yoke and bale if they are not damaged or corroded.

The strand vise should be used with a guy hook. Install a strand vise dead-end on a figure-eight cable as follows:

1. Determine where on the cable strand the strand vise will be mounted, then mark that location on the strand portion of the cable.

- If you are installing the dead-end grip at the end of a cable length or providing slack for a future splice point (prior to beginning the cable installation) allow for the appropriate slack requirements.
- If the dead-end grip is being installed on a tensioned cable at its installation level, ensure that the span is properly tensioned. Support the figure-eight cable extending beyond the dead end location to prevent damage from bending and or tension once the messenger is cut.

2. Separate the two figure-eight cable components with a web splitter or splicer's knife, starting about 11 inches (27.5 cm) ahead of where the messenger will enter the strandvise. The component separation length may vary with different strandvises. The actual length can best be determined by holding the strandvise you are using alongside the cable.

3. Determine the strip length required to fit the messenger component into the strandvise and provide sufficient length for a bonding/grounding clamp to be clamped on the exposed end(s) of the strand. At least 3 inches (7.5 cm) of stripped messenger should extend out of the strandvise. Finally, cut the messenger strand to length with a pair of bolt cutters.

4. Remove the jacket from the messenger component of the figure-eight cable by running a splicer's knife along the strand. Peel the jacket away from the strand. Perform this step with care to avoid personal injury and to avoid any damage to the anti-corrosive zinc coating of the strand.

5. Slide the bare messenger strand into the strandvise cartridge assembly as directed by the strandvise manufacturer's instructions.

6. Use a weather proofing tape around the strand at the point where the jacket is stripped off of the messenger to seal the jacket from water entry.

7. Use weather resistant cable ties or straps to re-connect the separated stand and cable and to keep the separation from propagating along the cable

7.2 Figure-Eight Placing Procedure

Figure-eight cable can be placed using both the stationary reel and the moving reel methods. The moving reel method is the preferred method, if right-of-way is generally free of obstructions that would inhibit the movement of the moving cable reel. The moving reel method is much easier to setup and is usually more cost effective than the stationary reel method for self-supporting cable.

7.2.1 Figure-Eight Placing Procedure

If the moving reel method is used, the cable is suspended off temporary blocks attached to each support structure (pole); no other hardware is required. If the stationary cable method is used, it requires that a messenger strand is available to support cable blocks every 35 feet to temporarily support the figure-eight cable until it is tensioned and attached to the poles. It is very likely the moving reel method will be chosen over the stationary reel method.

The installation of self-supporting, Fibre optic cables should begin only after the support infrastructure is properly guyed and capable of resisting the weight and tensile load it will receive during and after cable placement.

Figure-eight optical cables should be installed using the moving reel method whenever possible. It should be placed using cable blocks on the poles where it will remain during the remainder of the placing and tensioning operations. As with all placing methods, the maximum pulling tension and minimum bend radius of the cable should not exceed the manufacturer's recommendations.



Figure 9- Two Types of Cable Blocks: Clip on Strand (Left) and Bolt to Pole (Right)

The messenger strand portion of the figure-eight cable should be tensioned with the use of a dynamometer. Figure 10 shows a similar operation in which the messenger strand is being tensioned.



Figure 10- Tensioning the Messenger Strand Using a Dynamometer and Chain Hoist

Figure-eight cable tensioning is similar to tensioning the messenger strand for lashed cables except it has an optical cable component under the messenger component. The cable should be temporarily supported at each pole on rollers until after the cable has been tensioned at all dead-end poles and the tensioned equalized in all spans of the section being placed. The tangential camp at each intermediate pole should provide support to the stand component, but allow the cable to move freely as it is tensioned and as the tension equalizes.



Figure 11- Eight Optical Cable Tangential Clamp

Tension should be applied slowly while the entire length of cable being installed is observed for evidence of snagging or failure to move freely through its tangential supports at the poles.

The initial stringing tension for the cable will depend on the size of its support strand, the size of cable, the NESC storm loading district for the construction project, the span length, the temperature at the time of tensioning, and STL's recommendations.

After placement, tensioning, and attachment to the pole structure, the cable is spiraled by hand from alternate poles following the instructions found in Figure 12 (as found in RUS 1753F-152).



Figure 12- Spiraling Operation Detail, RUS 1753F-152

7.2.2 Stationary Reel Method

Where physical obstructions make it necessary to install figure-eight optical cables using the stationary reel method, cables should be strung through cable blocks under a sufficient amount of tension to avoid excessive bending and to avoid unsafe sag between poles. The stationary reel method is made much easier if a messenger strand exists from which to suspend the required cable blocks. The blocks should be spaced approximately 35 feet apart. When using this installation method the maximum pulling tension and minimum bend radius of the self-supporting, optical cable should not exceed the manufacturer's recommendations.

Care should be exercised to prevent continuous spiraling from occurring during the stationary reel method installation of the figure-eight cable. The use of a ball-bearing fused swivel will be helpful in eliminating most spirals and also in maintaining a safe cable tension during placement.



Figure 13- Pulling Hardware to Place Cable During the First Stage of the Stationary Reel Placing Method

Since the cable will be spiraled by hand from alternate poles after tensioning (see), any existing spirals in the cable would be increased in one span and removed in the adjacent span. It would then be very difficult to obtain a uniform number of spirals in every span.

The initial sags and tensions for self-supporting, optical cables installed with various span lengths and at different temperatures in the three NESC storm loading districts should be obtained from STL. When tensioning figure-eight, optical cables, at intermediate support points, the insulation over the messenger strand should be left intact and not be damaged. Tensioning by means of grips placed over the insulated support strand is the preferred method, provided that the tensioning can be accomplished without rupturing the insulation.



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Figure 14- Figure-Eight Optical Cable Tangential Clamp

After placement, tensioning, and attachment to the pole structure, the cable is spiraled by hand from alternate poles; see Figure 12 for detailed instructions.

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